Nanosegregation, Microtexture and the Control of Brittle Failure

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Quantitative X-ray maps of elemental segregation can be obtained in a scanning transmission electron microscope (STEM): e.g., two images at the top show Fe (matrix) and Mo (segregant) maps obtained around a prior-austenite grain boundary in a low-alloy steel.

A major issue with X-ray maps in STEM is their noise nature, which degrades the information about elemental distributions, especially for low levels of segregants. We have applied principal component analysis (which is one of multivariate statistical analysis methods) to the same X-ray maps. As shown in the two images in the middle, noise components were significantly reduced compared with the original maps.

In addition, we have also developed methods to determine the boundary coverage (the number of excess atoms per unit area in the boundary plane) from the composition maps since the measured segregant compositions strongly depend on experimental conditions. To determine the boundary coverage, the specimen thickness is required. We have determined the thickness by applying the ζ-factor method. Two images at the bottom show the thickness and the Mo boundary coverage maps, respectively. Work continues to relate the boundary coverage to the boundary misorientation.